Olivo-cerebellar circuit. Structure and functions

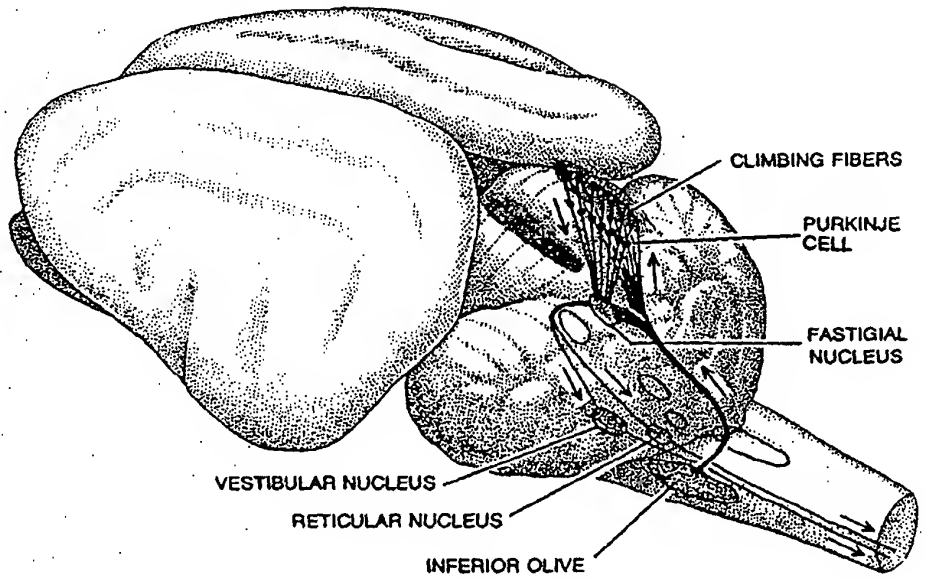


FIG. 1A

Olivo-cerebellar feedback loop.

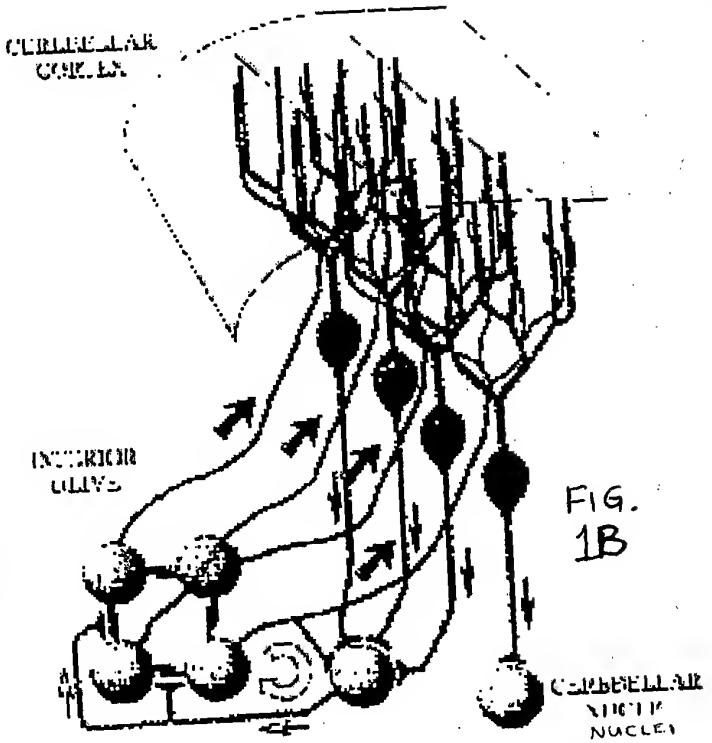


FIG. 1B

Functional circuit.

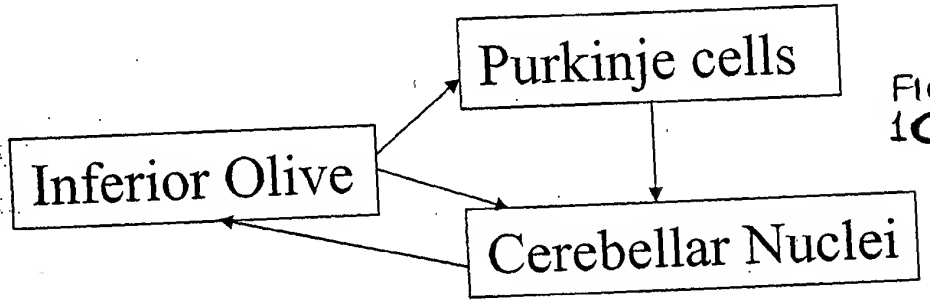
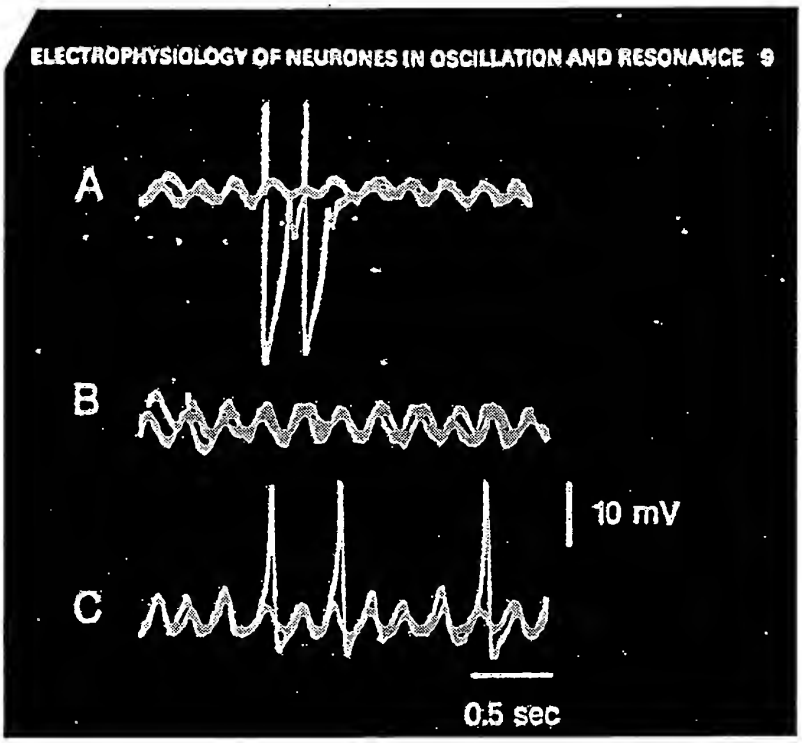


FIG. 1C

FIG. 2


ELECTROPHYSIOLOGY OF NEURONES IN OSCILLATION AND RESONANCE 9
A
B
C
10 mV
0.5 sec

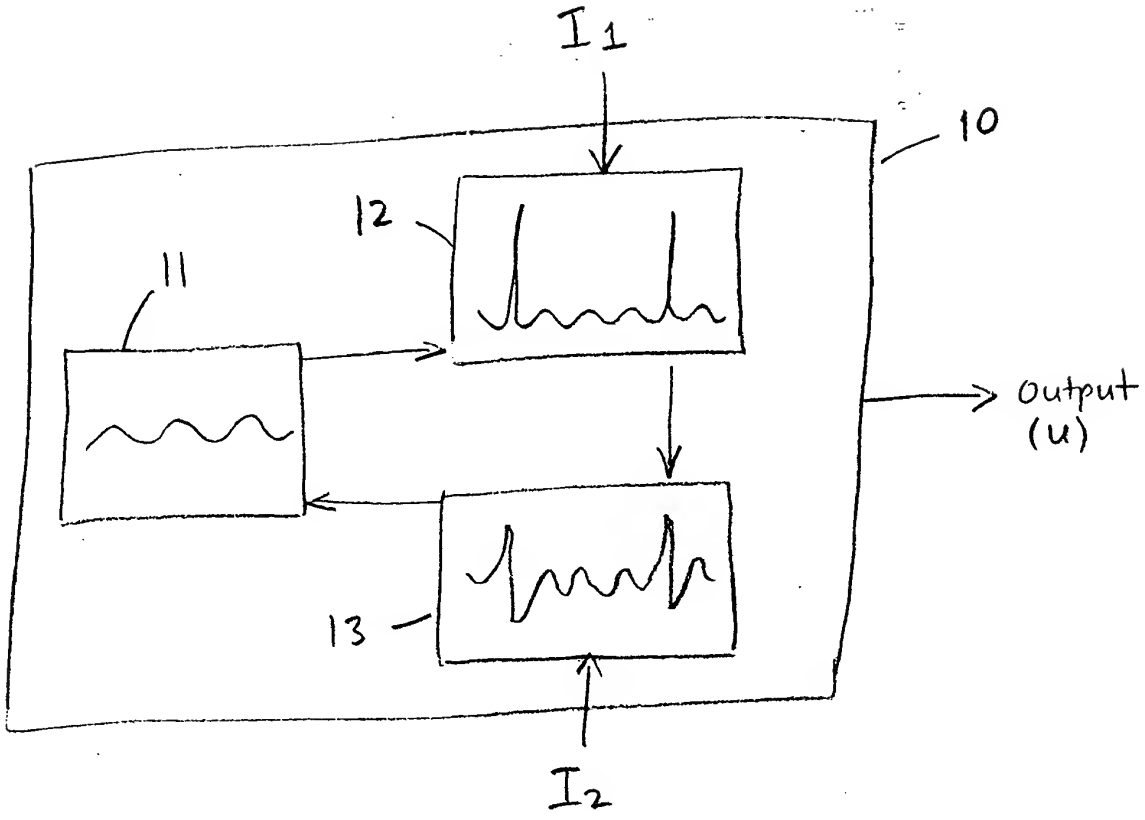


FIG. 3

FIG. 4

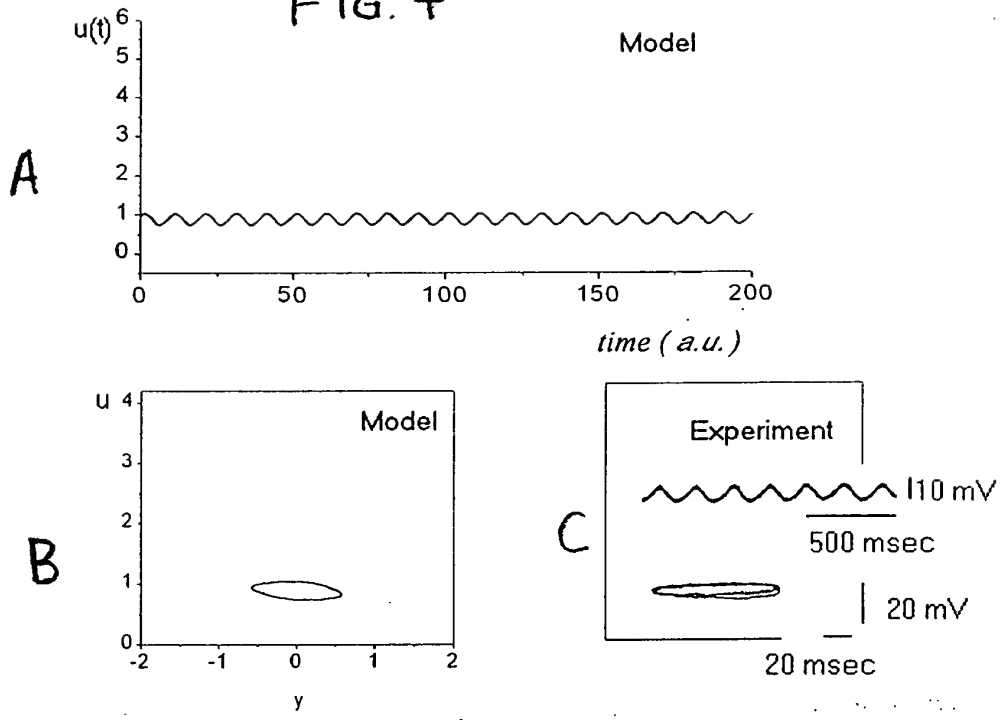
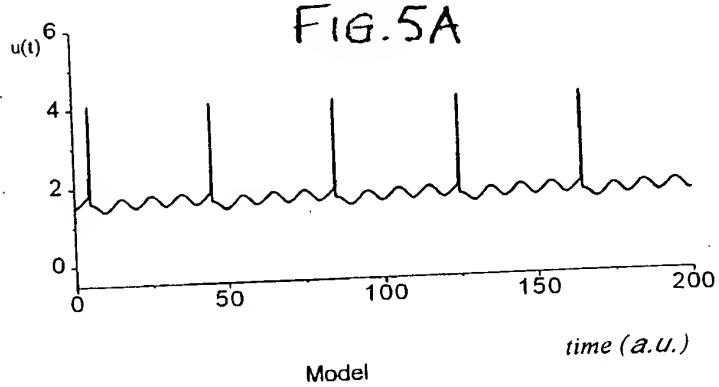


FIG. 5A



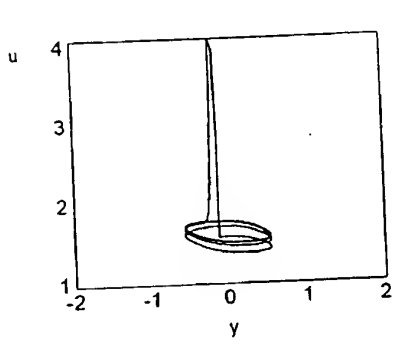


FIG. 5B

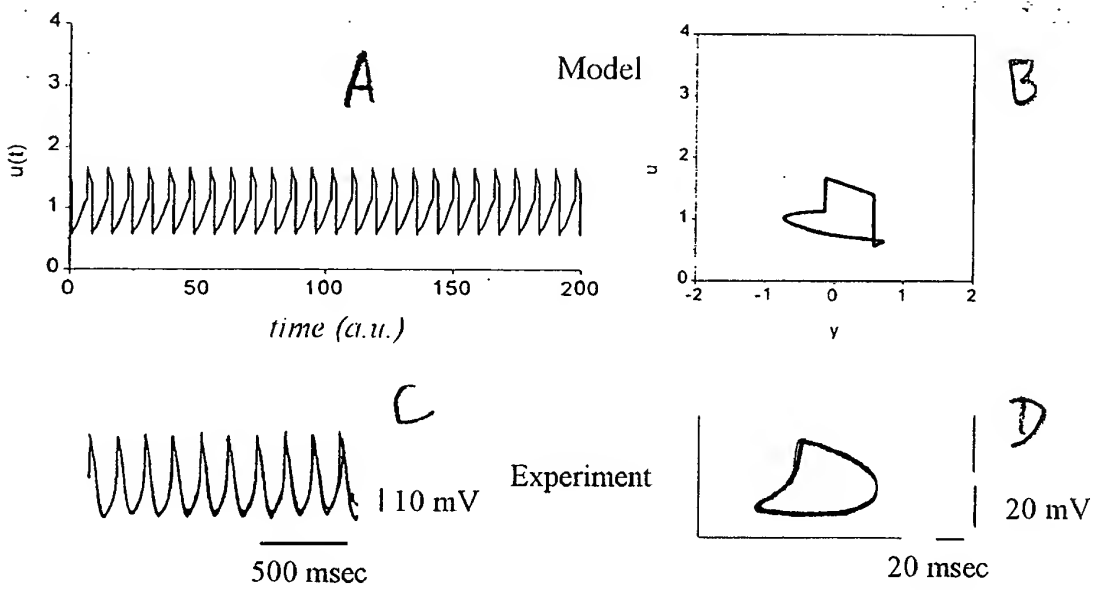

A
Model
B
u(t)
time (a.u.)
u
y
C
Experiment
D
10 mV
500 msec
20 mV
20 msec

FIG. 6

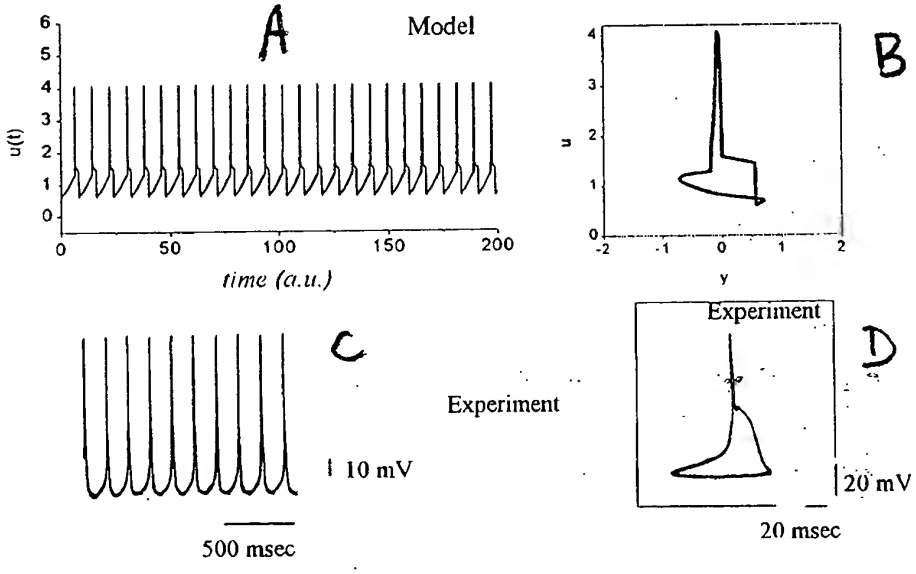

A
Model
B
u(t)
time (a.u.)
u
y
C
Experiment
D
Experiment
10 mV
500 msec
20 mV
20 msec

FIG. 7

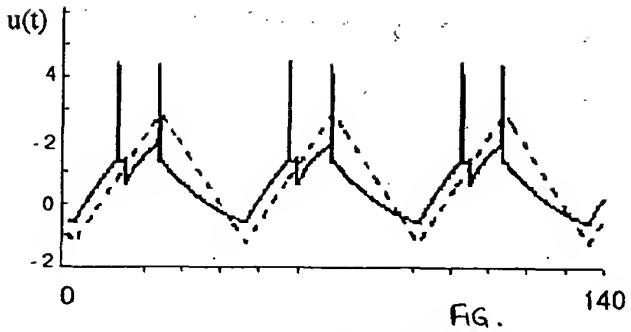


FIG. 8A

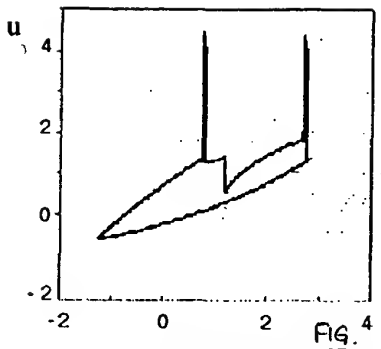


FIG. 8B

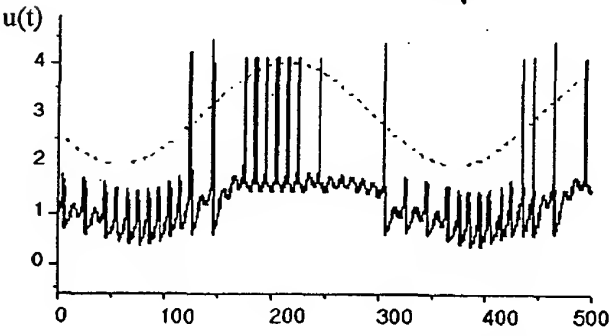


FIG. 8D

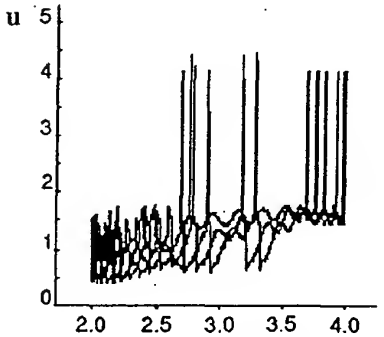


FIG. 8E

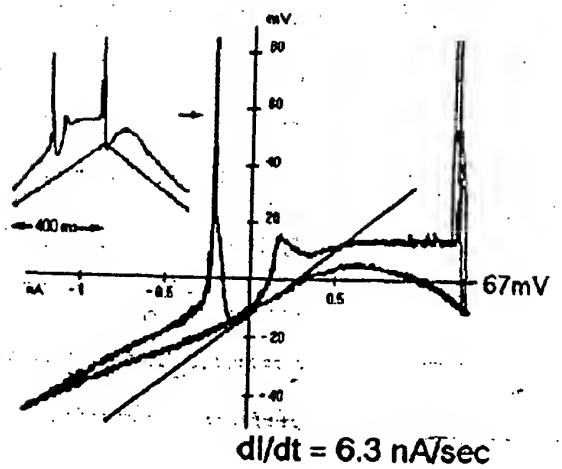
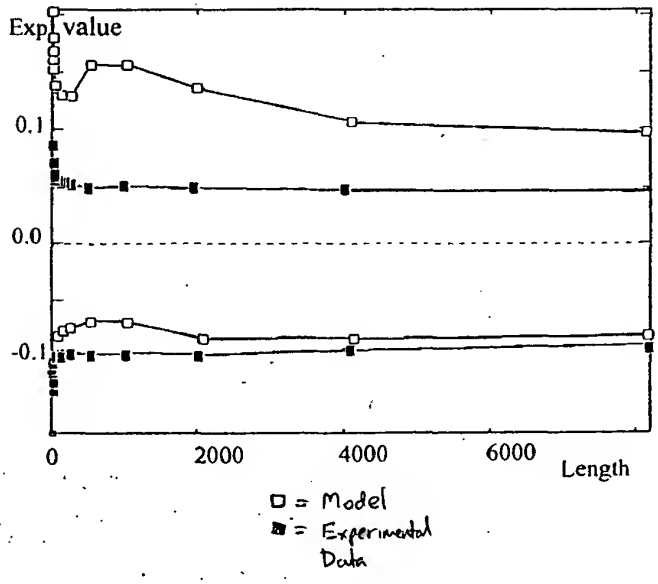


FIG. 8C

FIG. 9



Block-diagram of the circuit

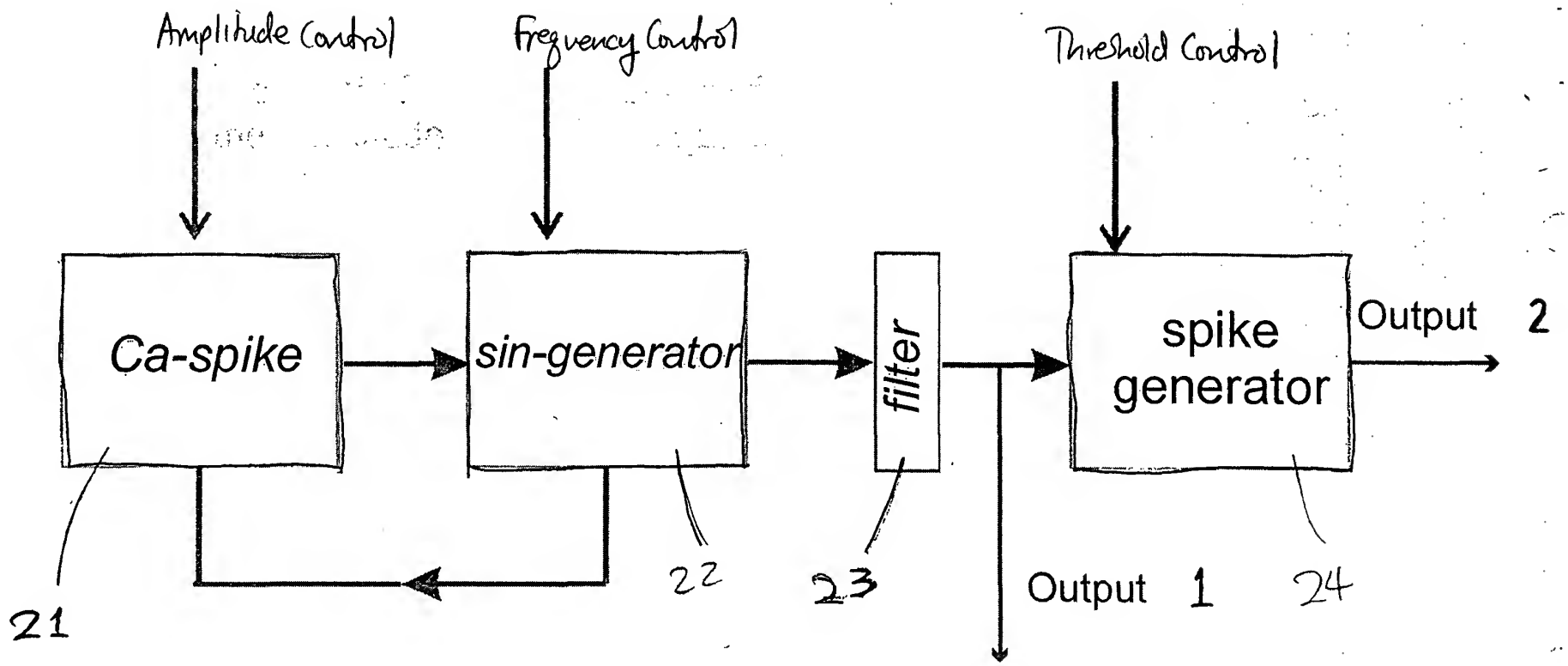


FIG. 10

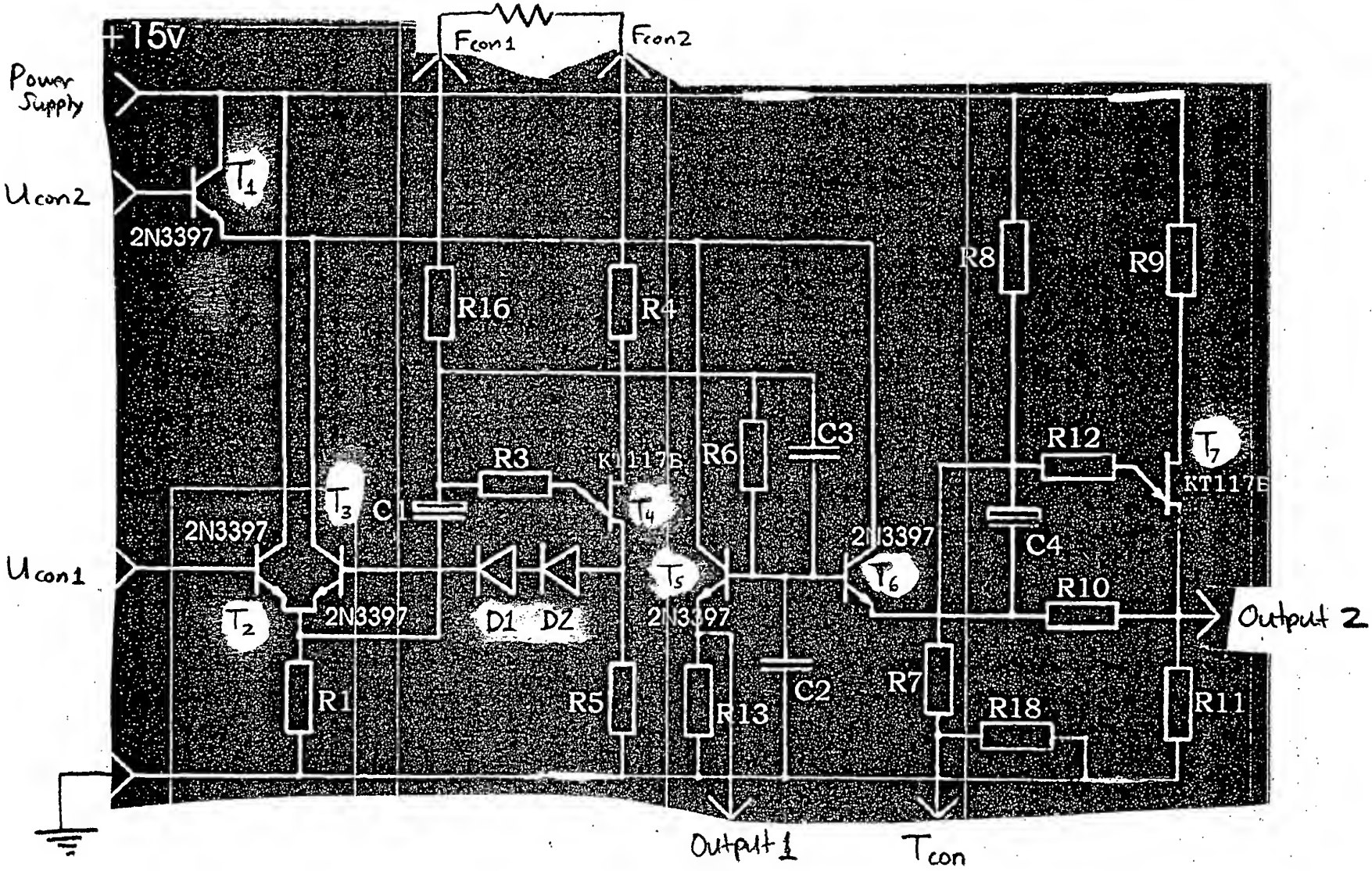

+15v
Fcon1
Fcon2
Power Supply
Ucon2
T1
2N3397
R16
R4
R8
R9
R3
C1
T3
T4
R6
C3
R12
T7
KT117E
2N3397
Ucon1
T2
2N3397
D1
D2
T5
T6
C4
R10
Output 2
R1
R5
R13
C2
R7
R18
R11
Output 1
Tcon

FIG. 11

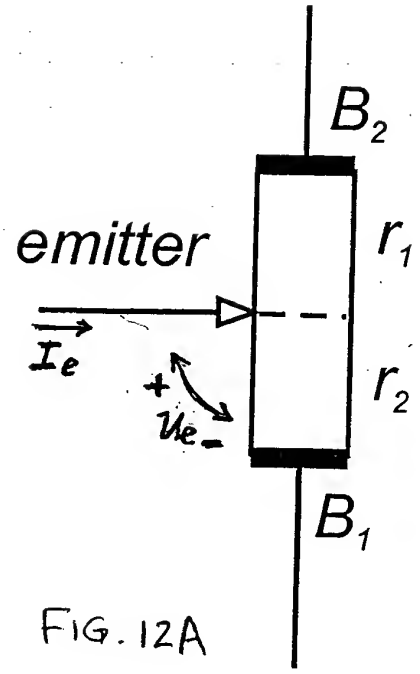


FIG. 12A

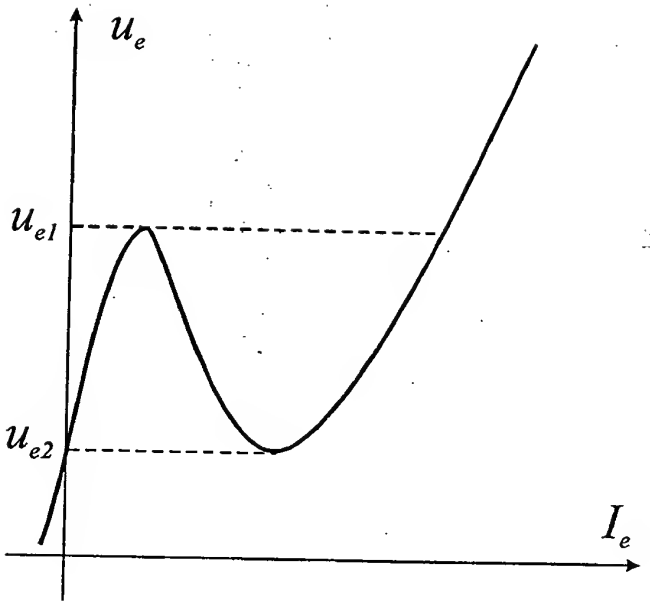
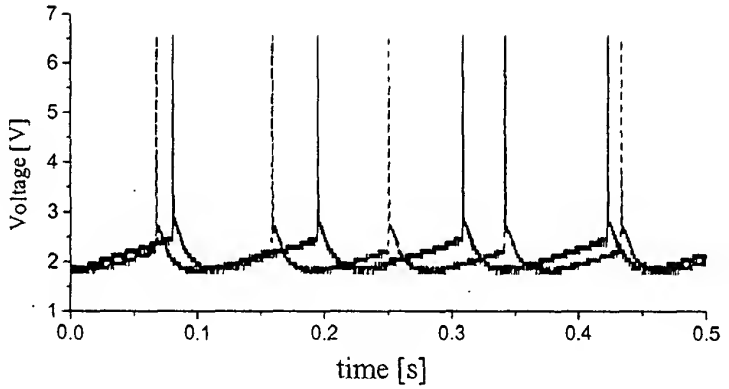


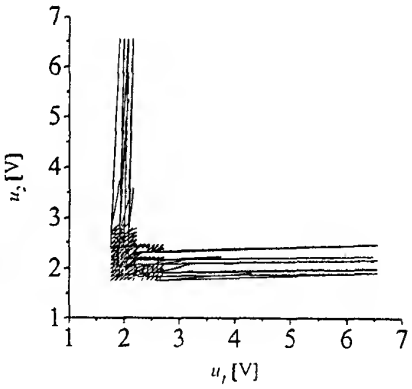
FIG. 12B

FIG. 13

Two chip experiments

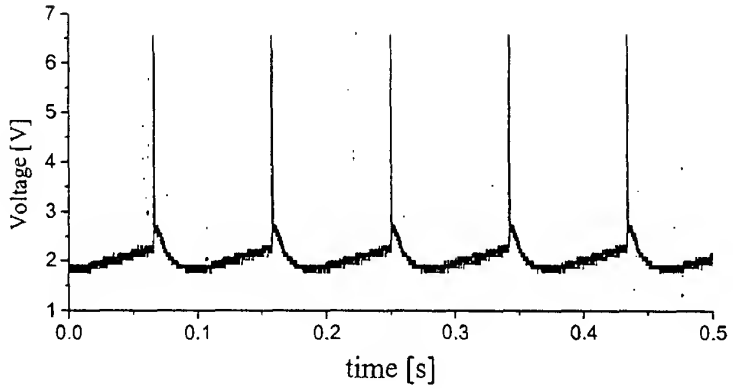


A

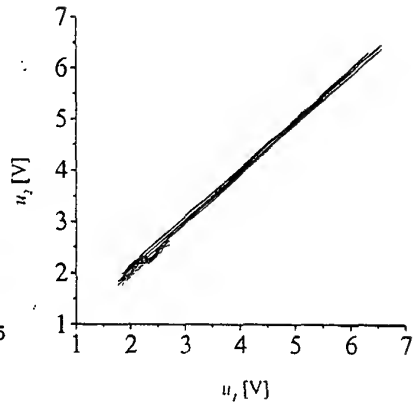


B

Uncoupled cells



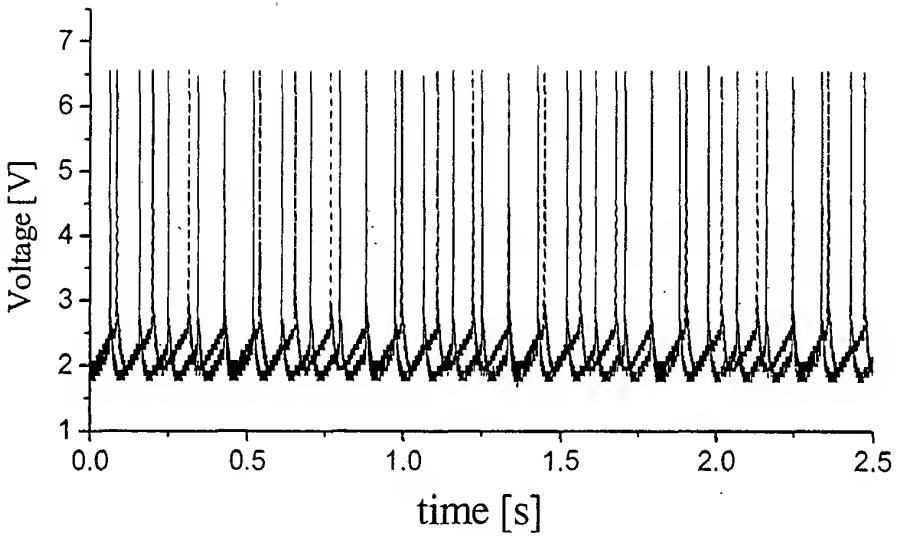
C



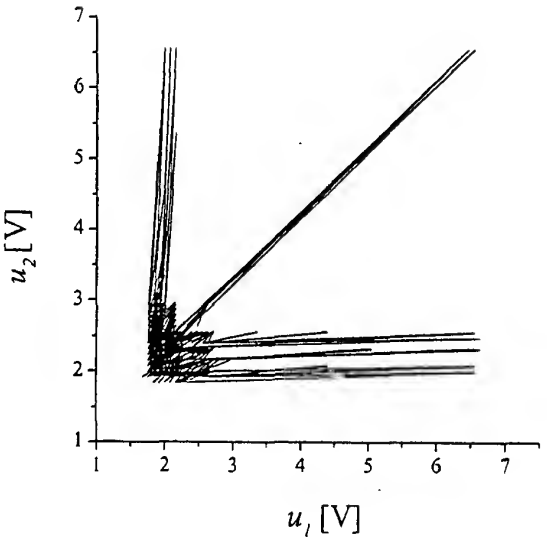
D

Synchronization

Synchronous and asynchronous spiking



A



B

Lower coupling

↓

Time-dependent in-phase spiking

FIG. 14

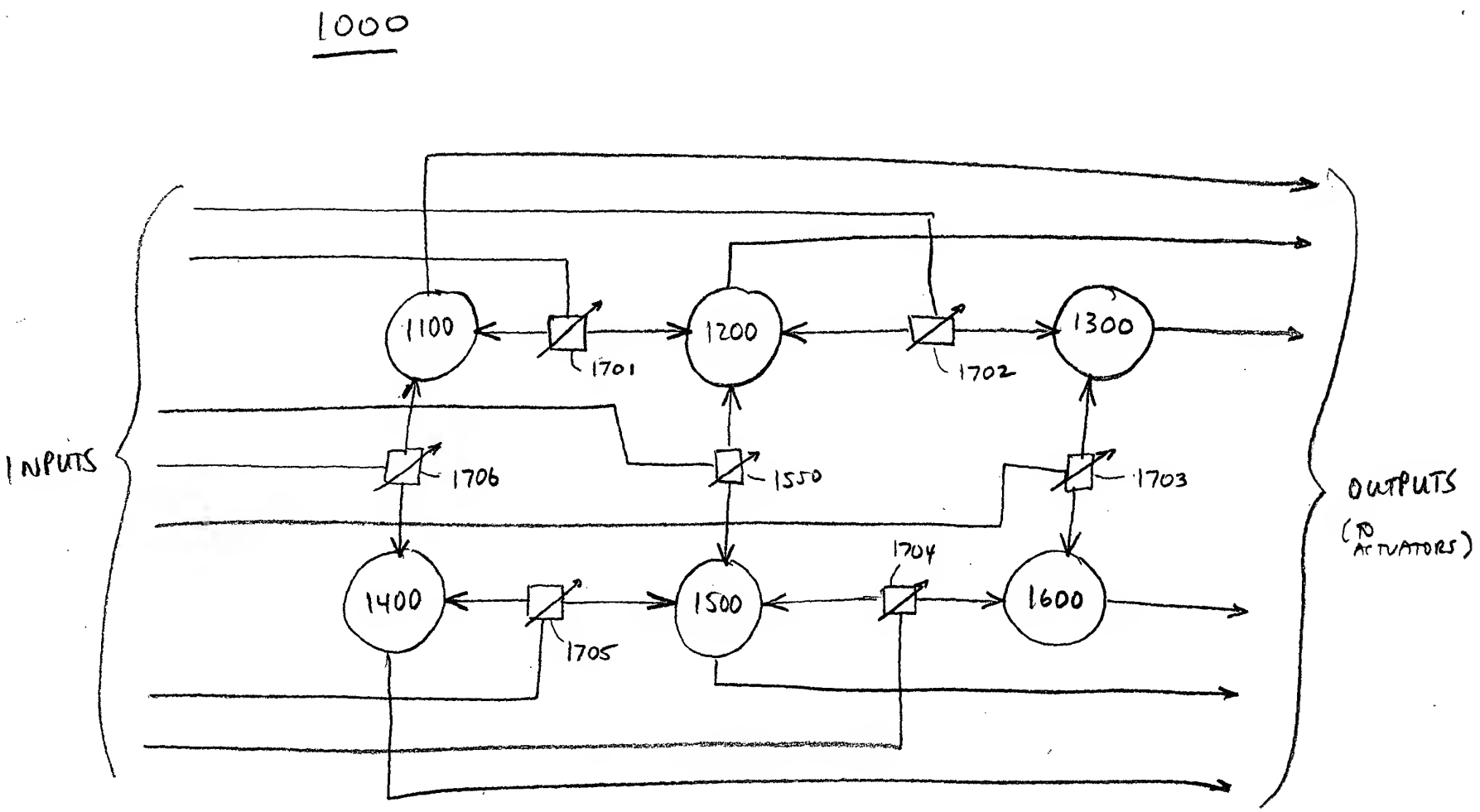

1000
INPUTS
1100
1200
1300
1400
1500
1600
1701
1702
1706
1550
1703
1704
1705
OUTPUTS
(TO ACTUATORS)

FIG. 15

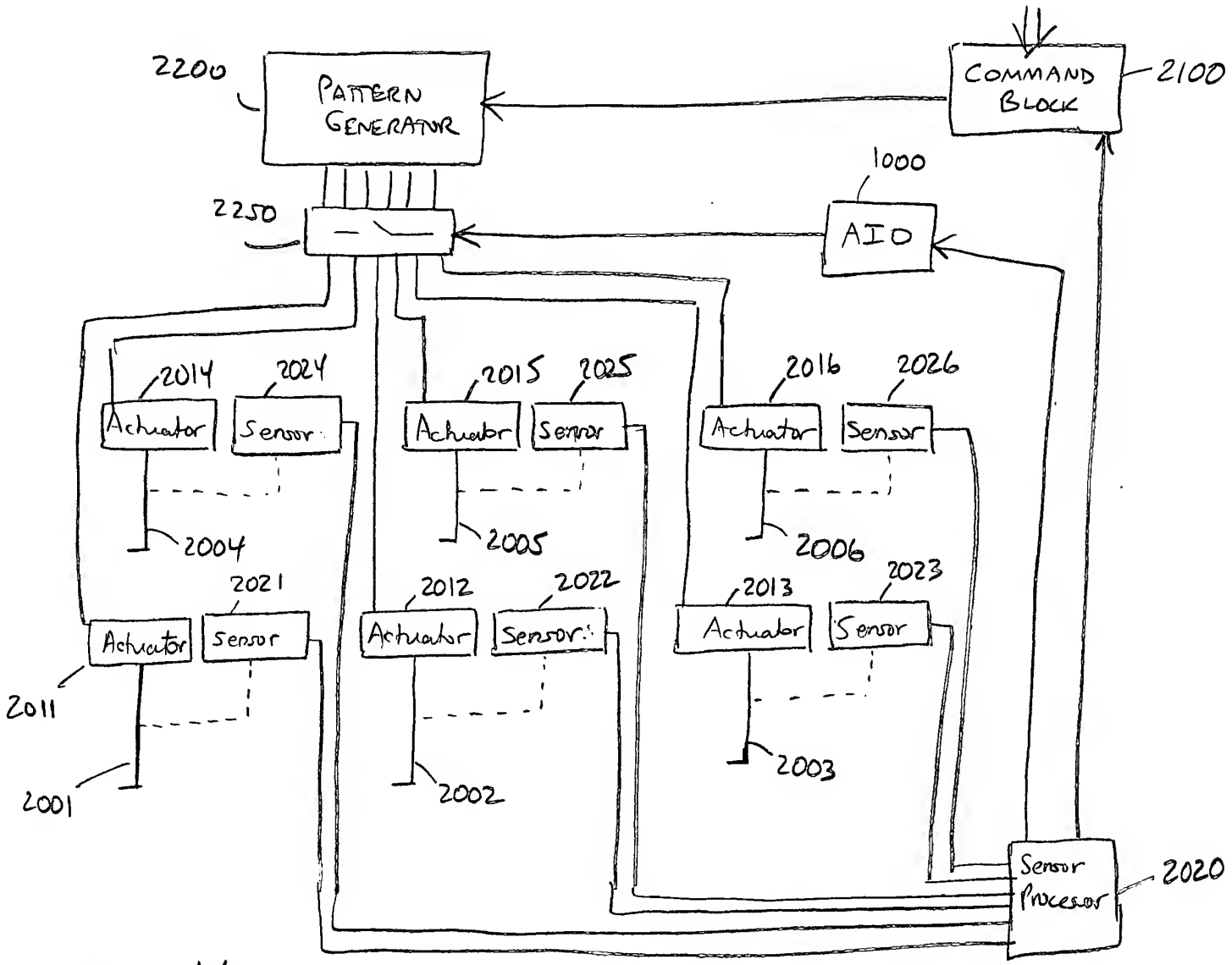

2200
PATTERN GENERATOR
COMMAND BLOCK
2100
1000
AIO
2250
2014
2024
2015
2025
2016
2026
Actuator
Sensor
Actuator
Sensor
Actuator
Sensor
2004
2005
2006
2021
2012
2022
2013
2023
Actuator
Sensor
Actuator
Sensor
Actuator
Sensor
2011
2001
2002
2003
Sensor Processor
2020

FIG. 16

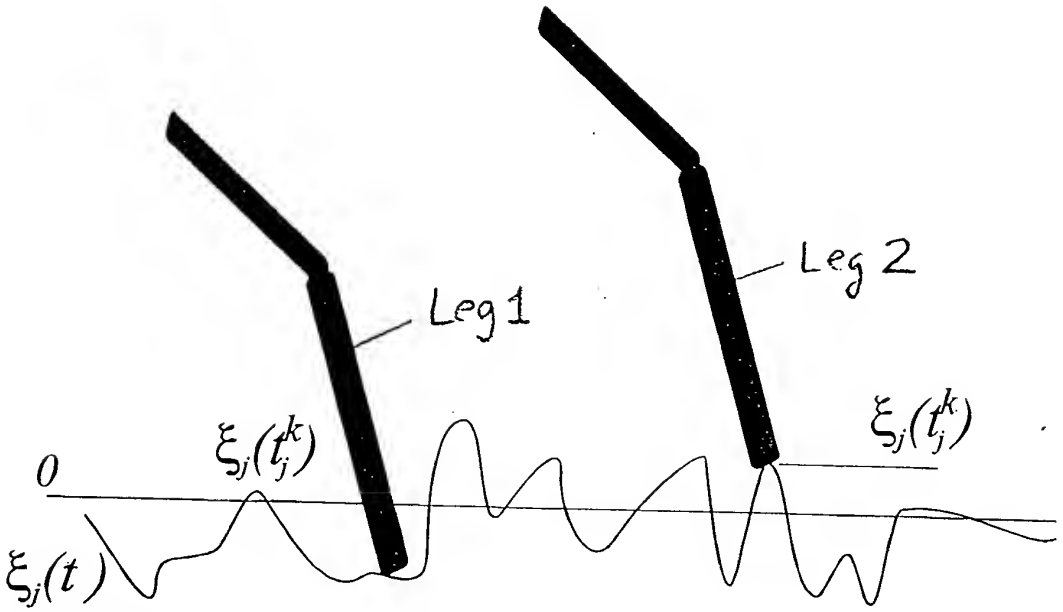
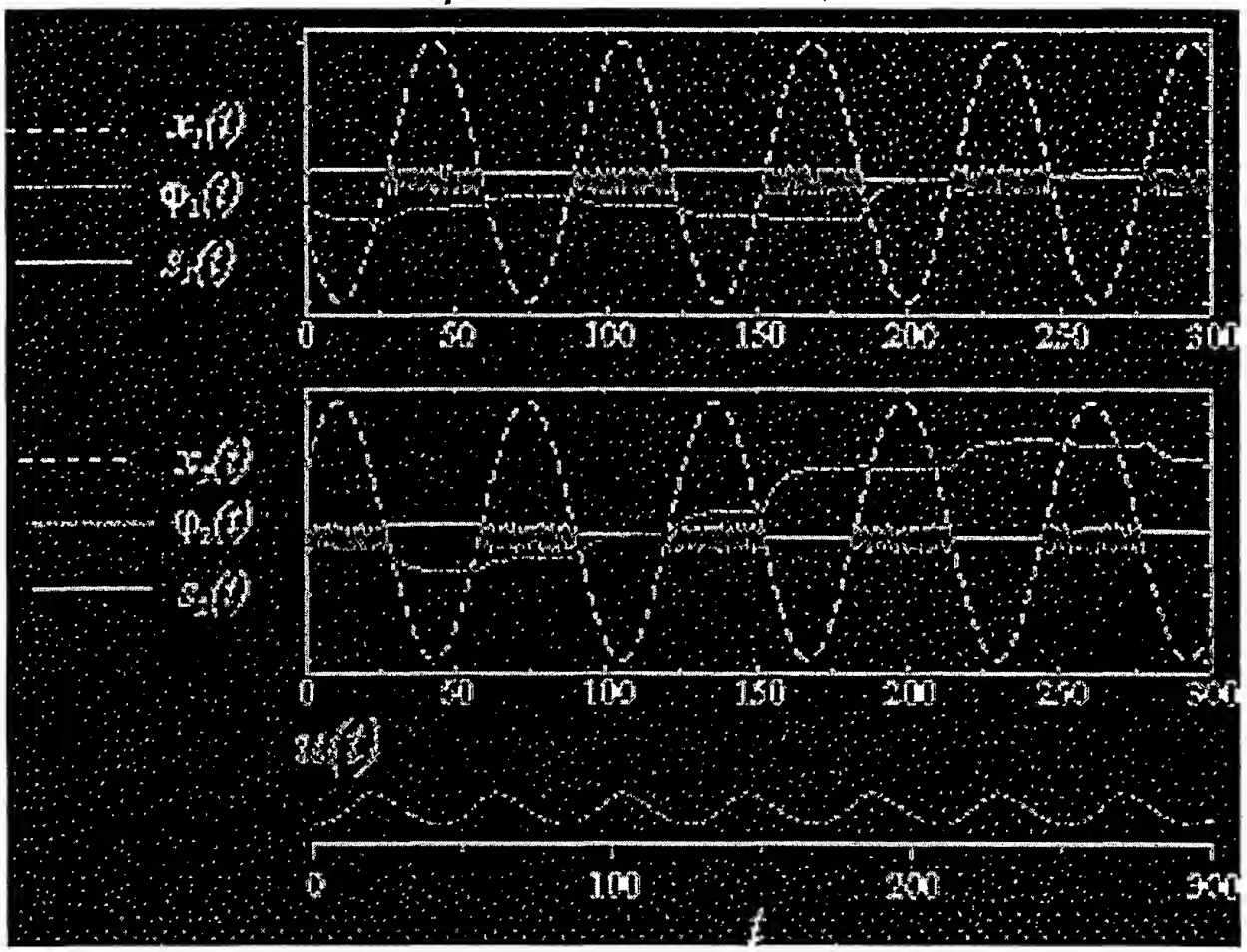


FIG. 17

Global phase coordination



A

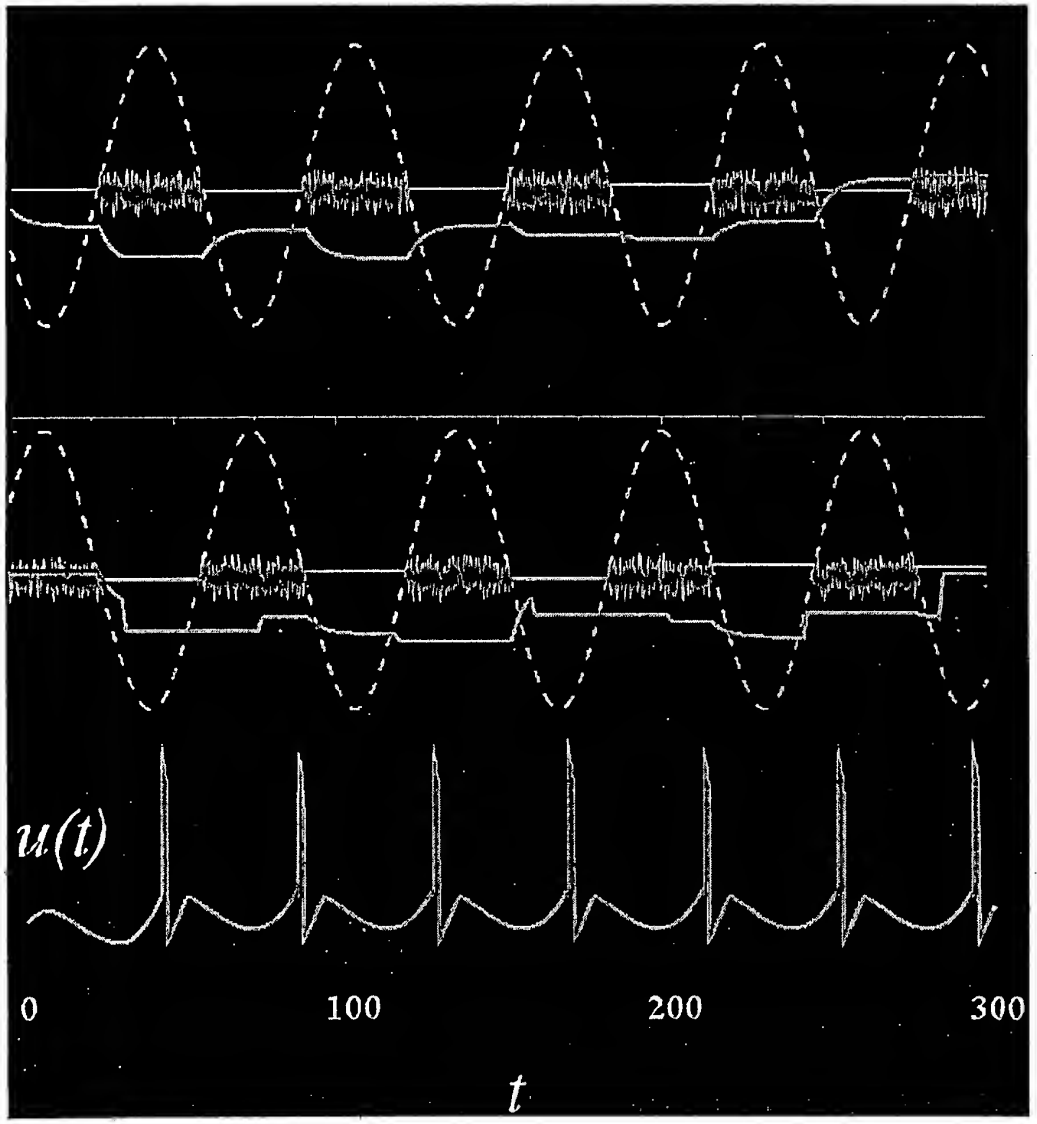
B

C

No control

FIG. 18

Coordination with discrete control

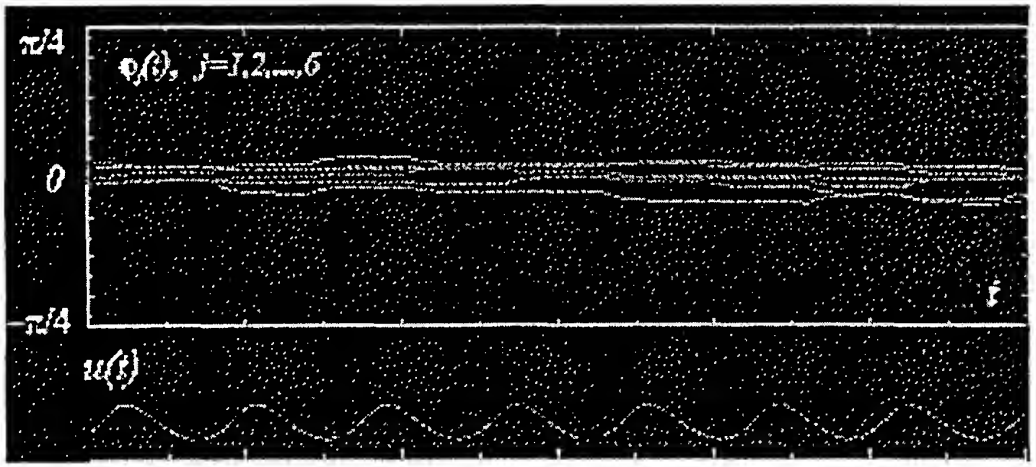


The control signal recovers the correct phase shift relations

FIG. 19

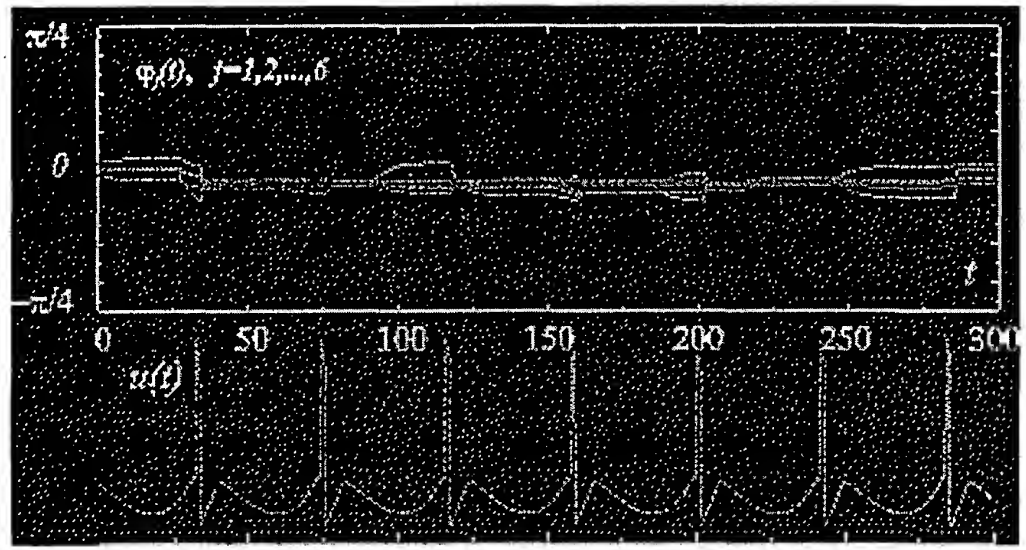
Evolution of phases

A



No control – phases evolve according to self-tuning mechanisms

B



Discrete control – the movement is controlled to sustain the walking gate

FIG. 20

17/24

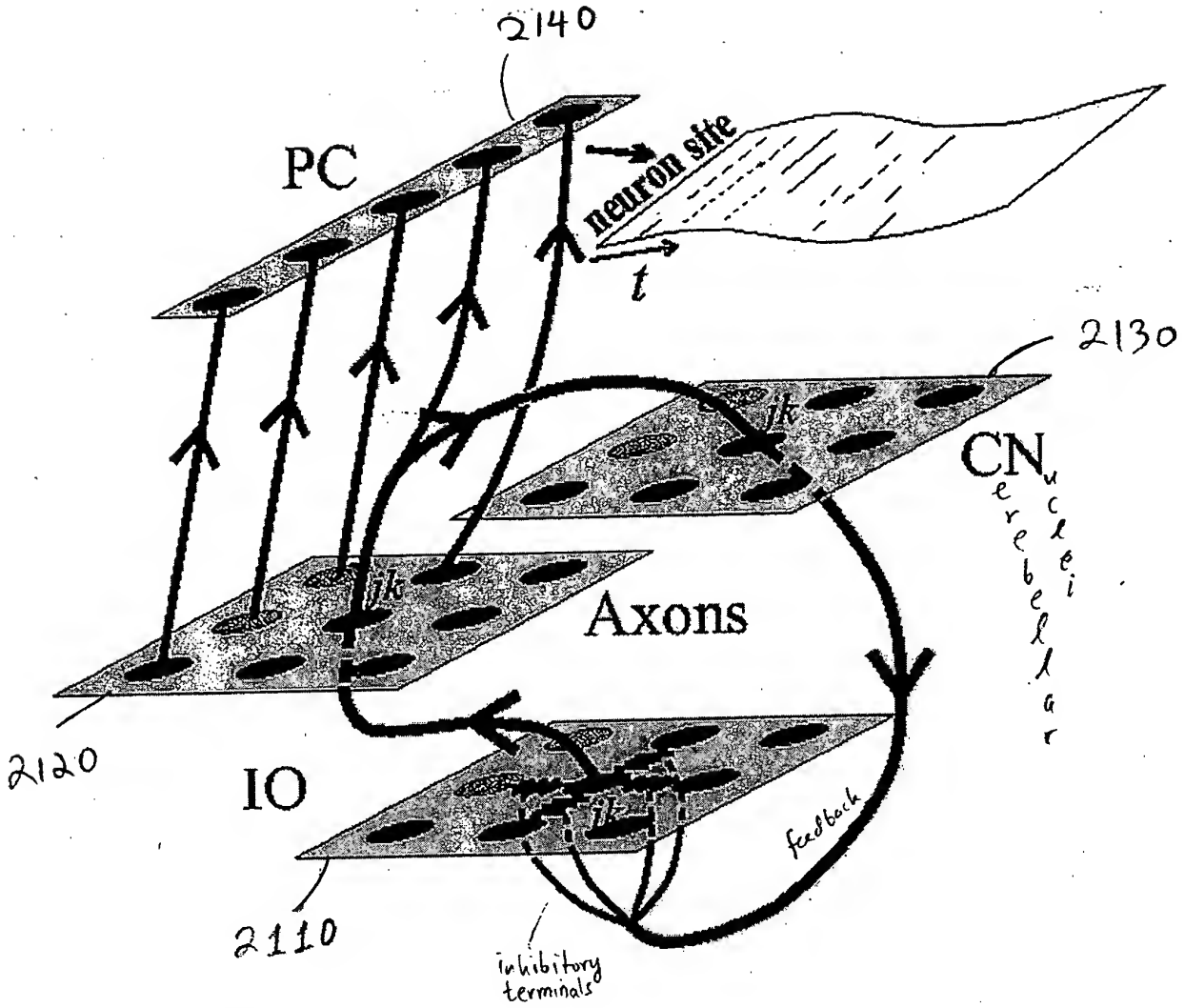

2140
PC
neuron site
t
2130
CN
cerebellar nuclei
jk
ik
Axons
2120
IO
ji
feedback
2110
inhibitory terminals

Figure 21

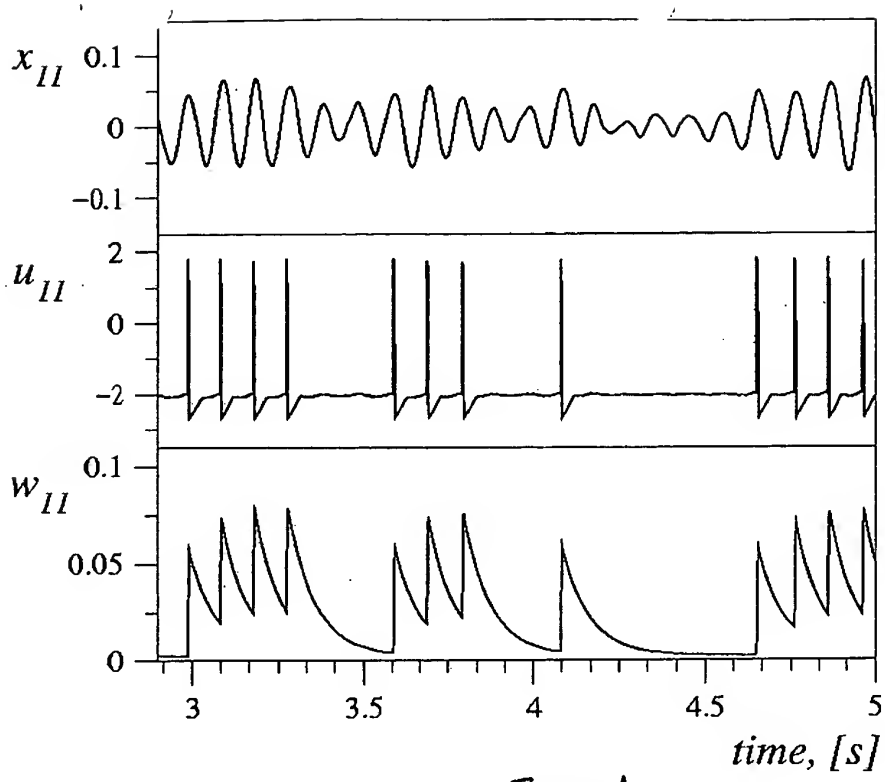


FIG. 22A

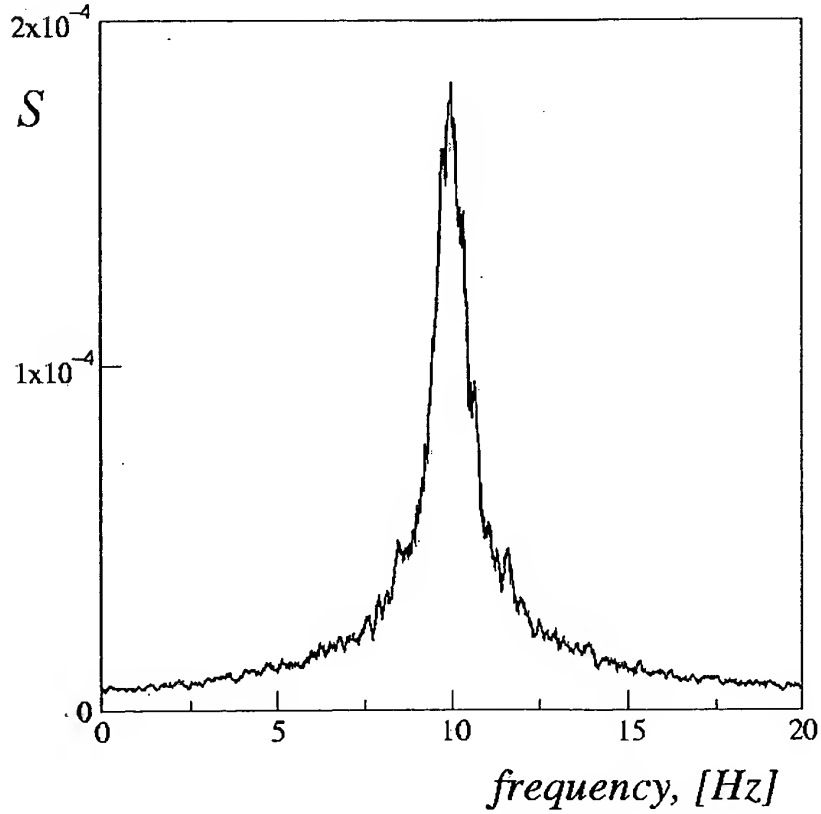
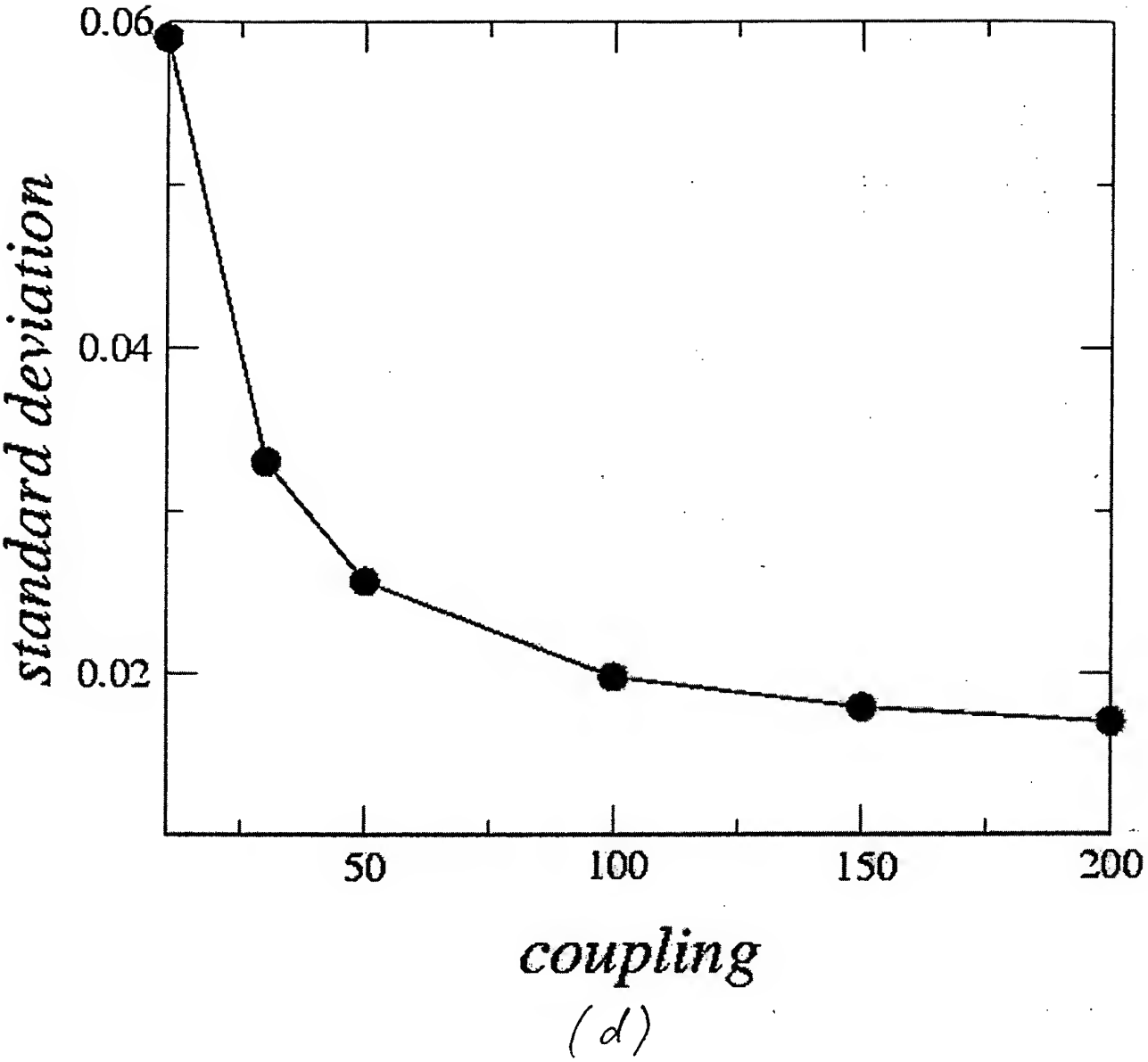
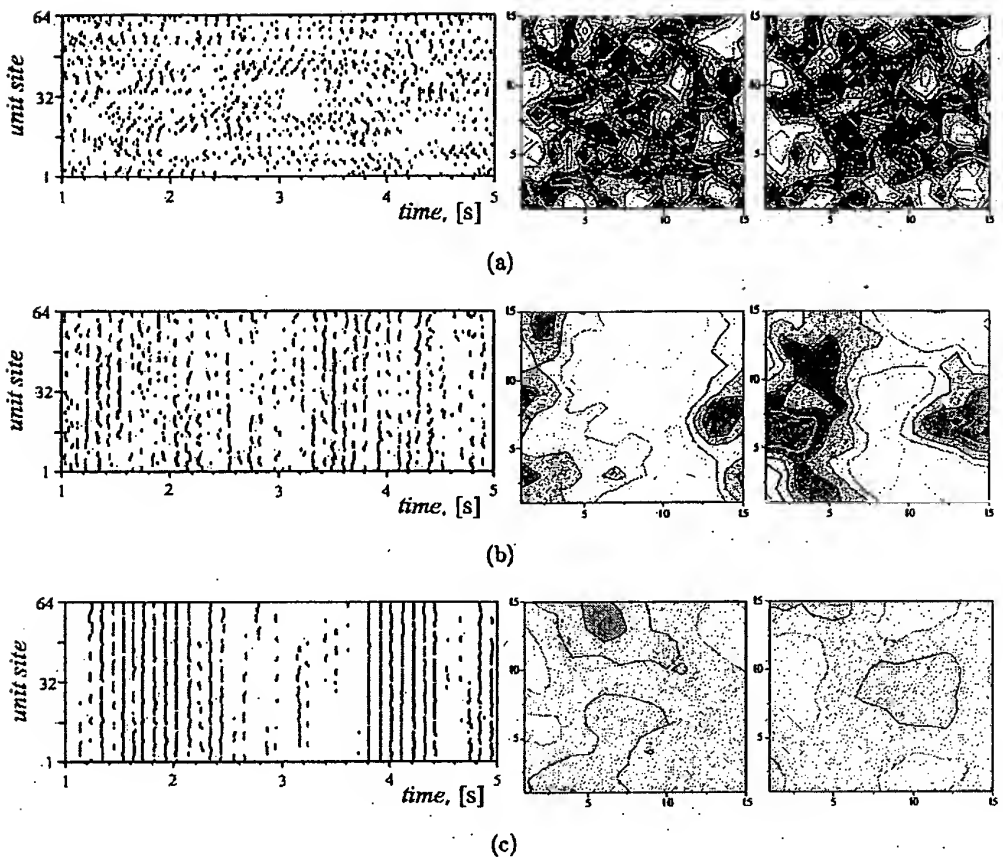


FIG. 22B



(d)

Figure 23



(a)

d = 0

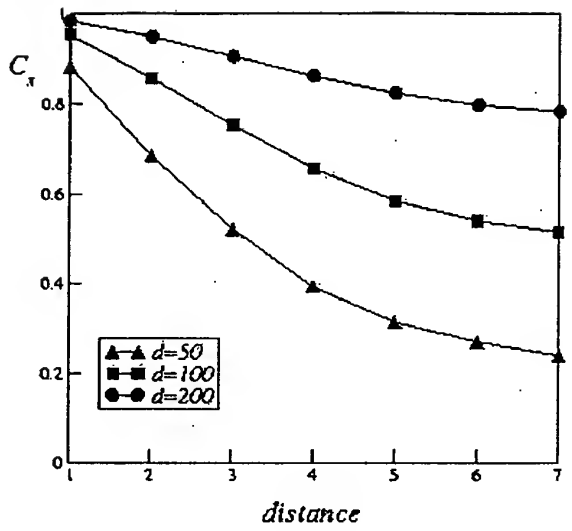
(b)

d = 50

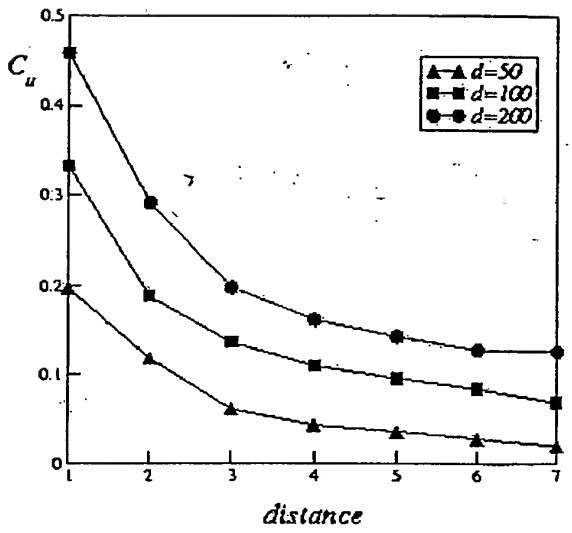
(c)

d = 200

Figure 24


C_x
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
d=50
d=100
d=200
distance

(a)


C_u
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
6
7
d=50
d=100
d=200
distance

(b)

Figure 25

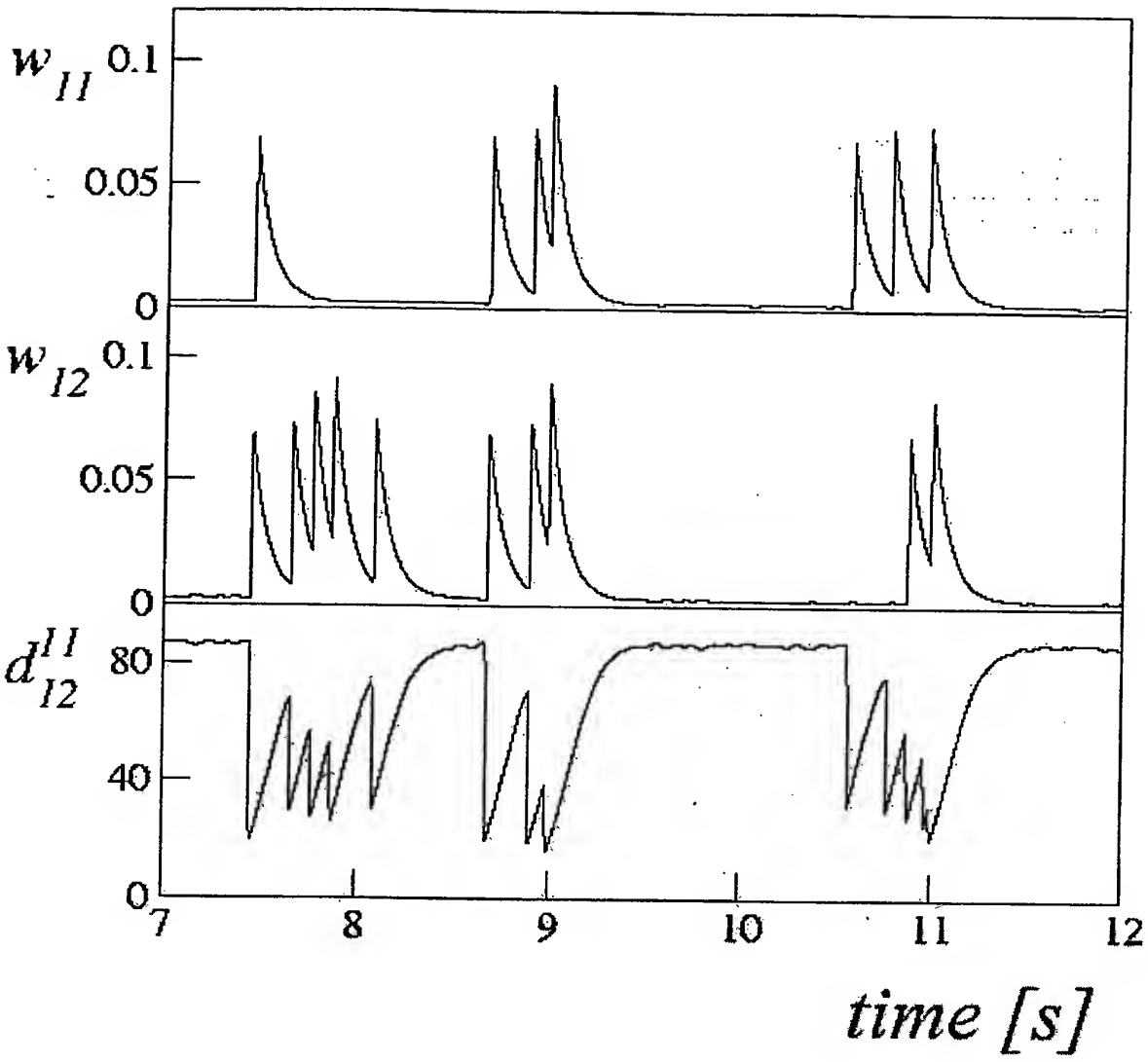
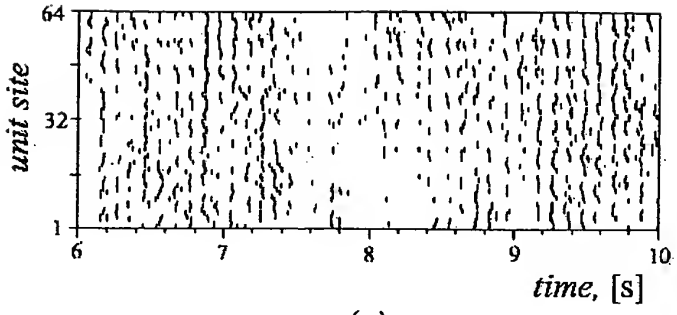
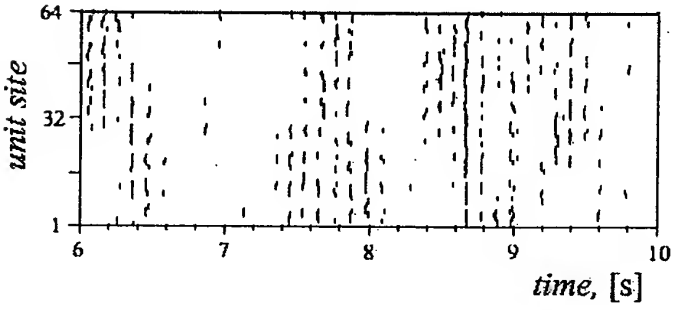


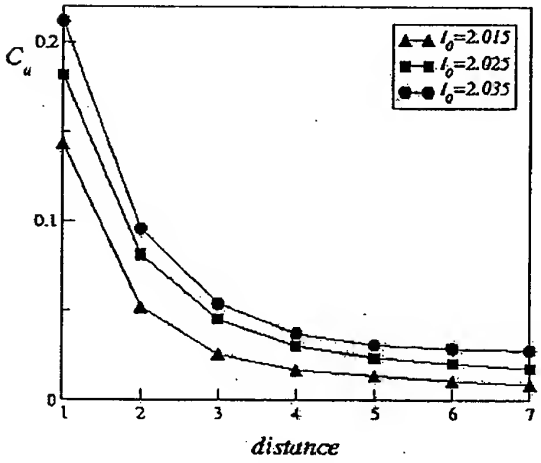
Figure 26



(a)

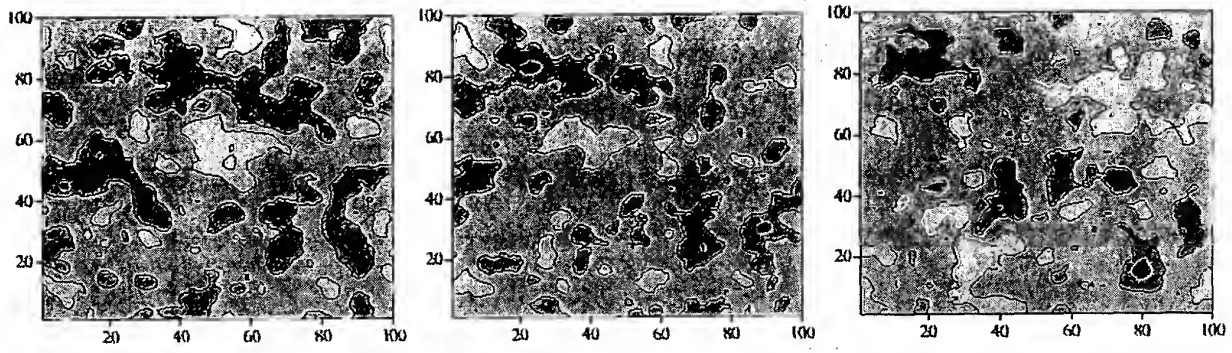


(b)

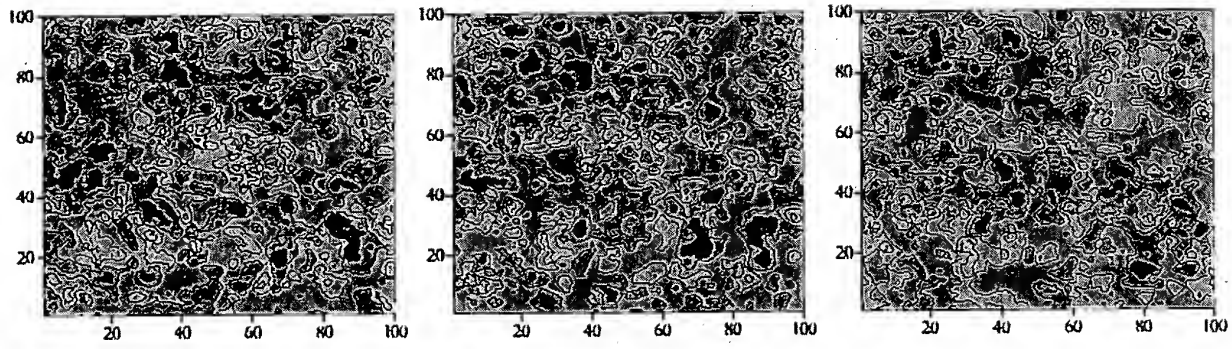


(c)

Figure 27



(a)

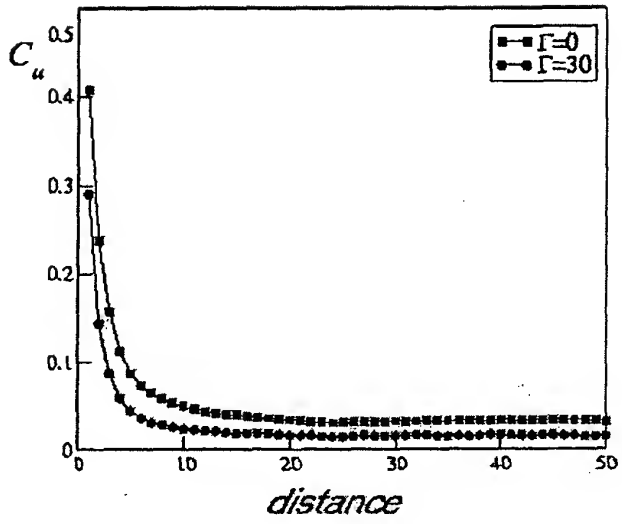


(b)

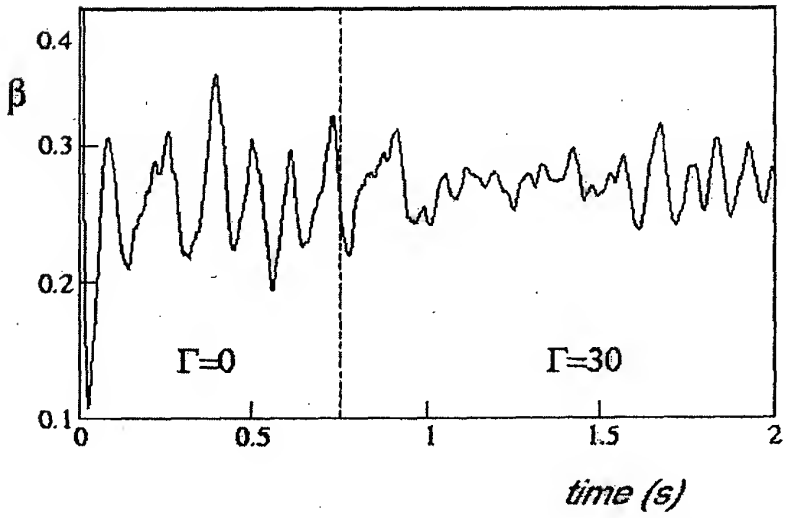
- constant coupling
- no feedback ($\Gamma = \phi$)

feedback
$\Gamma \neq \phi$

Figure 28


C_u
Γ=0
Γ=30
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
distance

(a)


β
0.4
0.3
0.2
0.1
Γ=0
Γ=30
0
0.5
1
1.5
2
time (s)

(b)

Figure 29

FIG. 30A

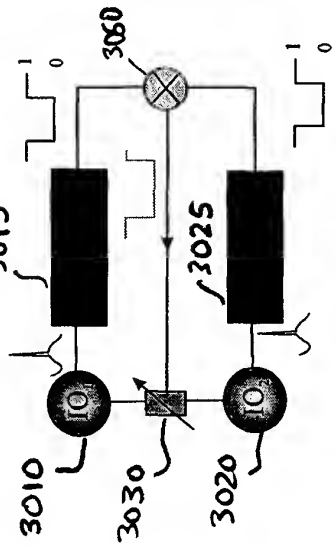


FIG. 30B

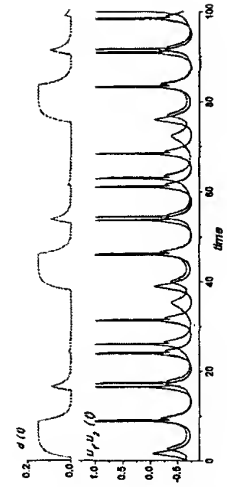


FIG. 31A

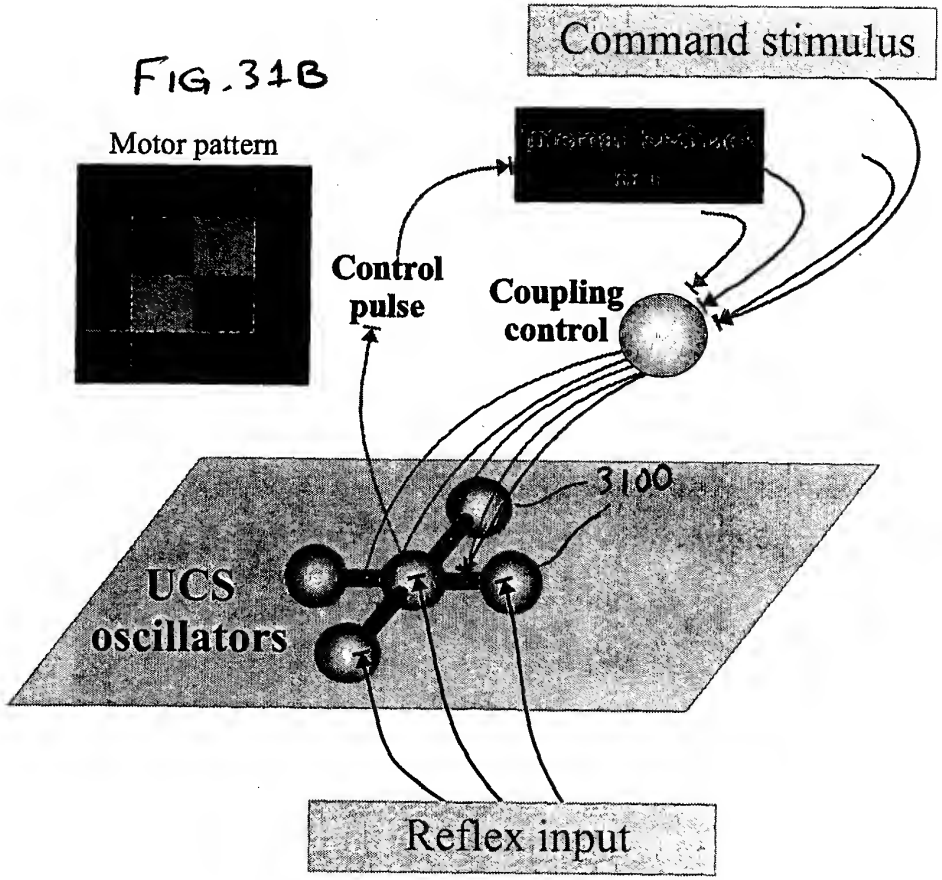


FIG. 31B

FIG. 32A

FIG. 32B

FIG. 32C

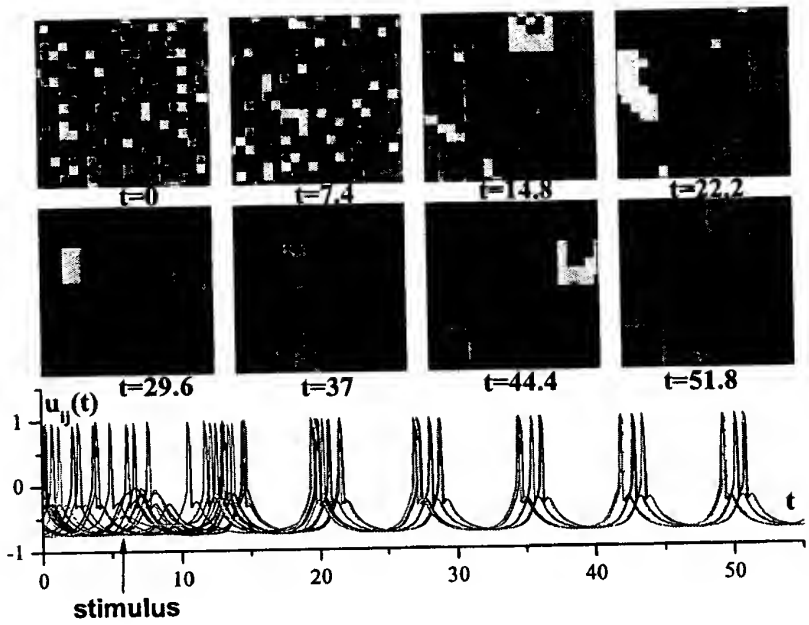


FIG. 33A

FIG. 33B

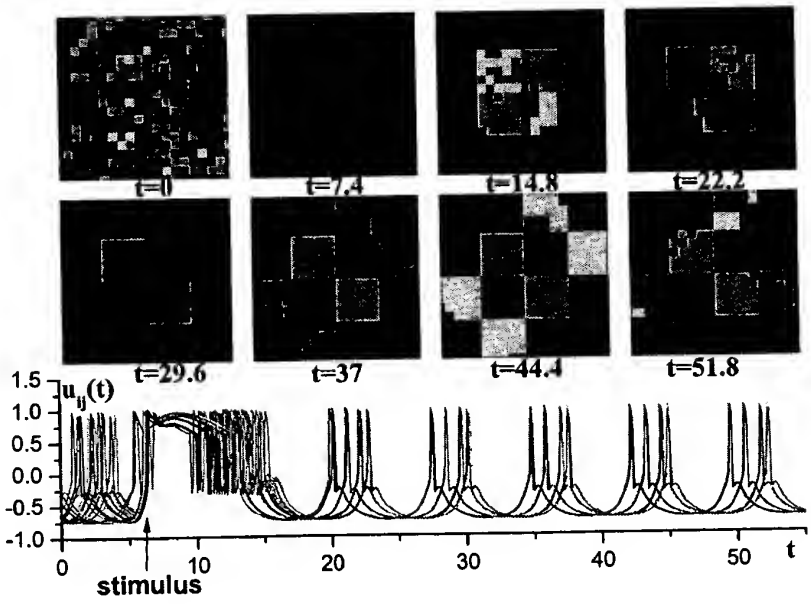



FIG. 33C